What is claimed is:

1.   A damper for mitigating torsional vibrations of a shaft, rotating with an angular velocity about a longintudinal axis, and rotating perpendicular to a plane of rotation, said damper comprising:

5   at least one passive damping element, and
                    one controlling damping element.

2.   The damper of claim 1 wherein said at least one passive damping element comprises:

                    a spring having a spring constant of proportionality with respect
10   to motion in a first degree of freedom,

                    a mass coupled to said spring for oscillation along said first degree of freedom, wherein said oscillation dampens said torsional vibrations of said shaft corresponding to a frequency of said oscillation,

                    a selector coupled to said spring for movement along said
15   spring in a second degree of freedom, said movement under governance of said angular velocity of said shaft, such that said spring constant of said spring, for said oscillation, is selected.

3.   The damper of claim 1 wherein said at least one passive damping element comprises:

20   a joint, displaced from said longitudinal axis, and in said plane,

                    a pendulum having a degree of freedom for pendulum motion, about said joint, said motion in said plane, such that said pendulum motion dampens said torsional vibrations corresponding to the frequency of said pendulum motion.

25   4.   A damper for ameliorating torsional vibrations of a shaft, rotating with an angular velocity, said damper comprising:

a spring having a spring constant of proportionality with respect to motion in a first degree of freedom,

a mass coupled to said spring for oscillation along said first degree of freedom, wherein said oscillation dampens said torsional vibrations of said shaft corresponding to a frequency of said oscillation,

a selector coupled to said spring for movement along said spring in a second degree of freedom, said movement under governance of said angular velocity of said shaft, such that said spring constant of said spring, for said oscillation, is selected.

5.   The damper of claim 4 wherein said frequency is a constant multiple of said angular velocity.

6.   The damper of claim 5 wherein said frequency is a constant multiple of said angular velocity by a natural number.

7.   The damper of claim 4, claim 5 or claim 6 wherein said selector is said mass.

8.   A damper for reducing torsional vibrations of a shaft, rotating about a longintudinal axis, and perpendicular to a plane of rotation, said damper comprising:

a joint, displaced from said longitudinal axis, and in said plane,

a pendulum having a degree of freedom for pendulum motion, about said joint, said motion in said plane, such that said pendulum motion dampens said torsional vibrations corresponding to the frequency of said pendulum motion.

9.   The damper of claim 8 wherein said frequency is a constant multiple of the angular velocity of said shaft.

10.   The damper of claim 9 wherein said frequency is a constant multiple of the angular velocity of said shaft by a natural number.

5   11.   A damper for reducing torsional vibrations of a rotating shaft, said damper comprising:

        a first spring,

        a second spring,

        a mass physically coupled to said first spring and

10   electromagnetically coupled to said second spring for oscillation having a frequency, wherein said oscillation dampens said torsional vibrations of said shaft that correspond to said frequency,

        accelerometers coupled to the mass and the shaft for detecting the relative motion of said mass and said shaft,

15   a current generator for adjusting an electromagnetic bond whereby the second spring is coupled to the mass,

        a computer coupled to said accelerometers and said current generator for detecting at least one undesired torsional vibration, determining a corresponding dampening spring stiffness improvement, and signaling

20   current generator to adjust current in order to implement said improvement.

12.   The damper of claim 11 wherein said computer further comprises apparatus for calculating frequency and amplitude of said mass and said shaft oscillation, and phase differential between said mass to said shaft.

25   13.   The damper of claim 11 wherein said computer further comprises at least one spectrum analyzer per accelerometer.

14.   A method for damping torsional vibrations of a rotating shaft wherein said shaft includes a hub, a mass physically coupled to said hub via a first spring and coupled to said hub via a second spring and electromagnetic bond, said method comprising:

        (i) oscillating said mass angularly with respect to said hub in a manner that absorbs energy with a resonance related to the total effective spring constants of the first and second springs,

        (ii) identifying undesired harmonic motion in said mass relative to said hub,

        (iii) calculating applied current changes that, when applied by a current generator to said electromagnetic bond, change the total effective spring constant and improve dampening of the detected undesired harmonic motion, and

        (iv) applying said current changes.

15.   The method of claim 14 wherein step (iii) comprises calculating a current decrease if amplitude of oscillation of said hub is increasing and amplitude of oscillation of said mass is decreasing, calculating a current increase if oscillation of said hub is decreasing and oscillation of said mass is increasing, and calculating no applied current change if oscillation of said hub and oscillation of said mass are constant.

16.   The method of claim 14 wherein step (iii) comprises calculating a current decrease and mass amplitude increase if the amplitude of oscillation of said hub is increasing and, calculating a current increase and mass amplitude increase if oscillation of said hub is decreasing, and calculating no applied current change if oscillation of said hub is constant.

17.   The method of claim 14 wherein step (iii) comprises calculating current changes that will generate an additional harmonic force with a frequency equal to frequency of actual external force, and phase equal to – 90 °.

5   18.   The method of claim 14 wherein said (ii) identifying is performed by an apparatus including a motion-to-signal transducer.

19.   The method of claim 18 wherein said motion-to-signal transducer includes an accelerometer

20.   The method of claim 18 wherein said motion-to-signal
10 transducer includes a frequency detector.

21.   The method of claim 18 wherein said motion-to-signal transducer includes a spectrum analyzer.

22.   The damper of claim 1 wherein said at least one passive damping element comprises:
15   a spring having a spring constant of proportionality with respect to motion in a first degree of freedom,
            a mass coupled to said spring for (i) oscillation along said first degree of freedom, wherein said oscillation dampens said torsional vibrations of said shaft corresponding to a frequency of said oscillation, and (ii)
20 movement along said spring in a second degree of freedom, said movement under governance of said angular velocity of said shaft, such that said spring constant of said spring, for said oscillation, is selected.

23.   A damper for mitigating torsional vibrations of a shaft, rotating
with an angular velocity, said damper comprising:

          a spring having a spring constant of proportionality with respect
to motion in a first degree of freedom,

5   a mass coupled to said spring for (i) oscillation along said first
degree of freedom, wherein said oscillation dampens said torsional vibrations
of said shaft corresponding to a frequency of said oscillation, and (ii)
movement along said spring in a second degree of freedom, said movement
under governance of said angular velocity of said shaft, such that said spring
10   constant of said spring, for said oscillation, is selected.

24.   The damper of claim 22 wherein said frequency is a constant
multiple of said angular velocity.

25.   The damper of claim 23 wherein said frequency is a constant
multiple of said angular velocity by a natural number.
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26.   The damper of claim 1 wherein said at least one passive
damping element comprises:

          at least two springs having two spring constants of
proportionality with respect to motion in a first degree of freedom,

20   a mass coupled to said two springs for oscillation along said first
degree of freedom, wherein said oscillation dampens said torsional vibrations
of said shaft corresponding to a frequency of said oscillation,

          and wherein said mass is coupled to said two springs for
movement in a second degree of freedom, said movement under governance
25   of said angular velocity of said shaft, such that the moment of inertia of said
mass about said shaft is governed by said angular velocity.

27. The damper of claim 1 wherein the controlling daminping element is capable of damping at least one vibration of a frequency different from any resonant frequencies of the passing damping element.